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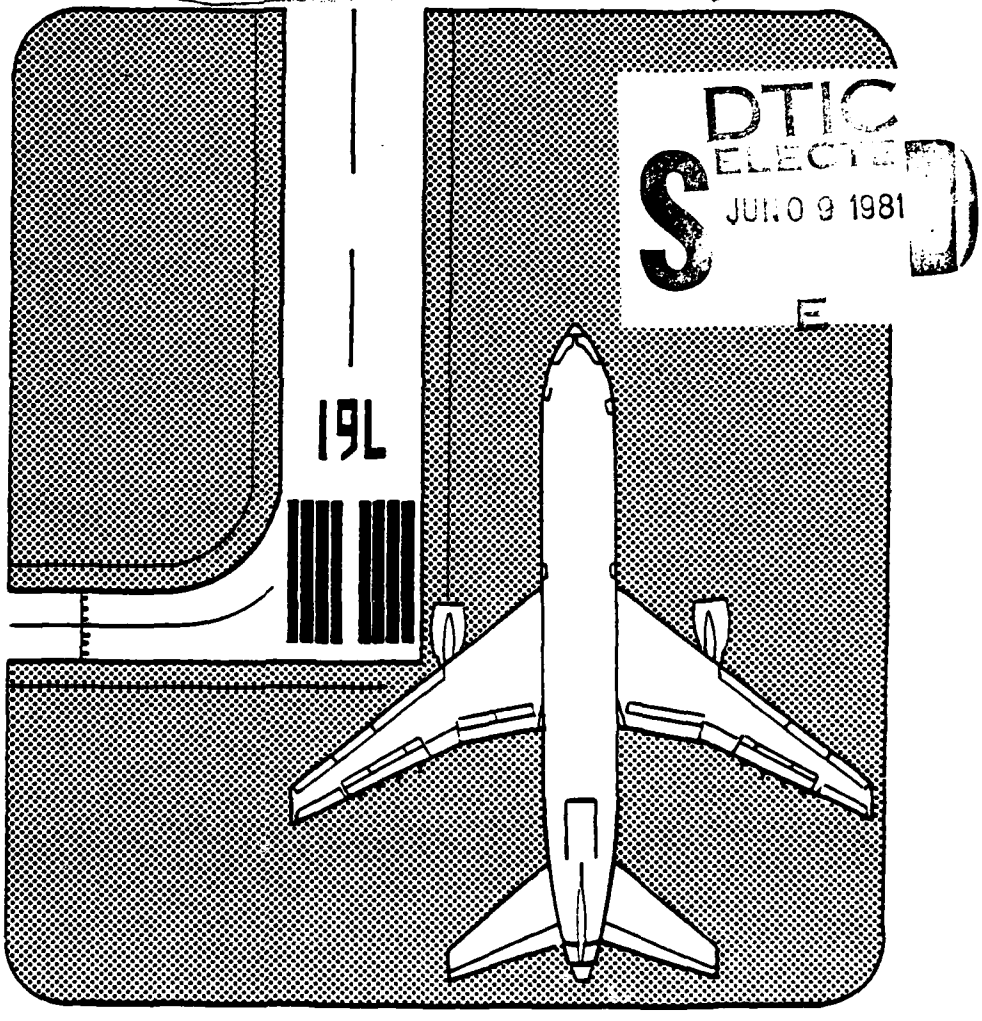
SAN FRANCISCO INTERNATIONAL AIRPORT

DATA PACKAGE Number 5.

LEVEL III

AIRPORT IMPROVEMENT TASK FORCE DELAY STUDIES.



prepared for

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PMM&Co. Peat, Marwick, Mitchell & Co.

APRIL 1979

PEAT, MARWICK, MITCHELL & Co.
P. O. BOX 8007
SAN FRANCISCO INTERNATIONAL AIRPORT
SAN FRANCISCO, CALIFORNIA 94128

Telephone: (415) 347-9521

April 18, 1979

Mr. Michael M. Scott, ATF-4
Federal Aviation Administration
800 Independence Avenue, S.W.
Washington, D.C. 20591

Re: San Francisco Data Package No. 5

Dear Mike:

Enclosed is Data Package No. 5 for San Francisco International Airport. The package contains improvement benefit descriptions (Attachment A) and results of the Stage 2 annual delay experiments (Attachment B).

These data should be reviewed by the San Francisco Task Force during the April 18, 1979, Task Force meeting.

Sincerely,

Stephen L. M. Hockaday
Manager

SLMH/nbe
Enclosure

cc: Mr. J. R. Dupree (ALG-312) (w/o enclosure)
Mr. Royal Mink (AWE-4) (hand deliver)

Attachment A

IMPROVEMENT BENEFIT DESCRIPTIONS

SAN FRANCISCO INTERNATIONAL AIRPORT

Airport Improvement Task Force Delay Studies

Peat, Marwick, Mitchell & Co.
San Francisco, California

April 18, 1979

Baseline Delays

Several delay experiments were designed to establish baseline delays for the years 1977 and 1982. To estimate baseline aircraft delays in the future, it was necessary to establish the most likely level of demand and the most likely future ATC scenario. Demand was forecasted to increase by 12% from 1977 to 1982. The future ATC scenarios define reduced longitudinal separations between aircraft associated with implementation of E&D products. The following delays were obtained for VFR weather.

Experiment #	Demand	ATC Scenario	VFR Peak-Hour[a] Runway Delays (minutes) Arrival	VFR Peak-Hour[a] Runway Delays (minutes) Departure	Average Daily[b] Runway Delays (minutes) Arrival	Average Daily[b] Runway Delays (minutes) Departure
Baseline (1)	1977	1977	0.9	2.7	0.5	1.6
Baseline (19)	1982	1982	1.6	5.4	0.7	2.5
Baseline (6)	1977	1977	2.5	5.9	0.9	2.9
Baseline (22)	1982	1982	1.9	5.4	0.8	2.6

a. Peak-hour for arrivals and departures are not necessarily the same hour.
b. Averaged over 15 hours from 0600-2100.

Runway delays in the first configuration increase by over 60% for arrivals and 100% for departures in the peak hour. The second configuration benefits from improvements in place in 1982 (primarily, 10L/10R simultaneous departures and the extension of 1R/19L).

For similar runway uses--IFR weather, much higher delays were obtained:

Experiment #	Demand	ATC Scenario	IFR Peak-Hour Runway Delays (minutes) Arrival	IFR Peak-Hour Runway Delays (minutes) Departure	Average Daily Runway Delays (minutes) Arrival	Average Daily Runway Delays (minutes) Departure
Baseline (3)	1977	1977	60+	10.7	53.5	3.2
Baseline (20)	1982	1982	60+	27.6	60+	15.9
Baseline (5)	1977	1977	60+	4.4	55.3	1.3
Baseline (21)	1982	1982	60+	14.6	60+	3.5

Delay Reduction With ATC Equipment and Procedural Changes

Of the ATC equipment and procedural changes examined, the most significant delay reductions were associated with those which provided for simultaneous 10L/10R departures in VFR weather conditions (along with the extension of Taxiway K to improve access to 10L). In addition, the installation of VASI on 19R with the extension of 1L/19R was considered in the delay analysis.

10L/10R Departures, Extend Taxiway K. Current ATC procedures normally allow for only a single departure stream from Runways 10L and 10R even in VFR weather. Access to 10L is also restricted by departures from 10R.

The improvement option defined by the Task Force assumes that aircraft can depart from 10L and 10R simultaneously (providing neither is a heavy aircraft). Improved taxiway access is also assumed.

Two experiments demonstrate the delay savings associated with the improvement options:

Experiment #	Demand	ATC Scenario	VFR Peak-Hour Runway Delays (minutes)		Average Daily Runway Delays (minutes)	
			Arrival	Departure	Arrival	Departure
Baseline (6)	1977	1977	2.5	5.9	0.9	2.9
Improvement (12)	1977	1977	2.6	2.5	0.9	1.6

The ability to allow simultaneous departures on 10L/10R can substantially reduce departure runway delays--from almost 6 minutes to 2-1/2 minutes in the peak hour. Arrival runway delays are not significantly affected.

VASI on 19R, extend 1L/19R. Currently runway 1L/19R is only 7,000 feet long, and there is no glide slope information available for 19R. Consequently, use of 19R by arrivals is restricted.

One potential improvement assessed by the Task Force calls for extending 1L/19R to at least 8,500 feet, and installing a 3-bar VASI system on 19R. This would permit more arrivals to use 19R, allow for a more balanced use of Runways 19L and 19R, and improve controller flexibility.

Two experiments demonstrate delay savings in VFR weather conditions:

Experiment #	Demand	ATC Scenario	VFR Peak-Hour Runway Delays (minutes) Arrival	Departure	Average Daily Runway Delays (minutes) Arrival	Departure
Baseline (6)	1977	1977	2.5	5.9	0.9	2.9
Improvement (11)	1977	1977	1.2	6.3	0.6	3.1

This improvement reduces arrival runway delays in the peak demand hour by 50%. Departure delays increase slightly due to smaller gaps between arrivals.

Delay Reduction With Physical Improvements

Physical Improvements considered by the Task Force included the extension of Taxiways L and V, and using Taxiways L and C as utility runways.

Extention of Taxiways L and V. Currently, when operating arrivals and departures on runways 19L/19R, departure access to 19L raises considerable problems. Two or more queued departures on 19R prohibit taxiing aircraft access to 19L. Also, departures waiting to begin roll on 19L interfere with the approach glide slope control for arrivals, and occupy an active runway twice.

An improvement assessed by the Task Force involved the extension of taxiways L and V to the departure end of 19L. Such an extension permits better access for departures. It also permits smaller spacings between departures and arrivals since departures do not interfere with the arrival glide slope.

Two experiments assessed the benefits in IFR2 weather conditions:

Experiment #	Demand	ATC Scenario	IFR2 Peak-Hour Runway Delays (minutes) Arrival	Departure	Average Daily Runway Delays (minutes) Arrival	Departure
Baseline (9)	1977	1977	36.8	60+	12.4	48.0
Improvement (10)	1977	1977	36.4	38.5	12.7	20.4

The improvement dramatically reduces departure delays from over 60 minutes in the peak hour to under 40 minutes. Arrival delays are not significantly affected.

Utility Runways on Taxiways L and C

From a strictly operational point of view, under certain conditions, taxiways could be used as utility runways. Task Force experiments evaluated two such conditions.

Runway 1R is occasionally closed for repair. When it is, taxiway L could be used as a utility runway for light aircraft (ignoring environmental factors). Two experiments measured this benefit.

When operating straight 28 operations only one arrival stream might be permitted. Using taxiway C as a utility runway would allow light aircraft to be diverted from the runways to the taxiway. Two additional experiments evaluated this:

	VFR Peak-Hour Runway Delays (minutes)		Average Daily Runway Delays (minutes)	
	Arrival	Departure	Arrival	Departure
Taxiway L				
Baseline (14)	1.0	4.2	0.7	2.4
Improvement (13)	0.7	3.6	0.3	1.7
Taxiway C				
Baseline (15)	16.9	3.8	7.7	3.1
Improvement (18)	5.0	3.9	1.8	2.1

The use of taxiway L reduces arrival and departure runway delays. The use of Taxiway C as a utility runway under the conditions defined substantially reduced arrival delays. This is due primarily to the increase in arrival streams from one to two.

Delay Reductions due to Demand Management

The Task Force considered the delay impacts of demand management.

Two experiments demonstrated the impacts on delay of diverting all general aviation demand (11% of the total demand) in IFR weather conditions:

Experiment #	Demand	ATC Scenario	IFR Peak-Hour Runway Delays (minutes)		Average Daily Runway Delays (minutes)	
			Arrival	Departure	Arrival	Departure
Baseline (20)	1982	1982	60+	60+	60+	31.3
Improvement (20A)	1982	1982	51.7	34.1	24.4	19.3

Substantial decreases in delays would occur with all general aviation (excluding air taxi's) diverted to other airports. IFR peak-hour delays drop from over 60 minutes for all operations to 51.7 minutes for arrivals and 34.1 minutes for departures.

Attachment B

RESULTS OF STAGE 2 ANNUAL DELAY MODEL EXPERIMENTS

San Francisco International Airport

Airport Improvement Task Force Delay Studies

Peat, Marwick, Mitchell & Co.
San Francisco, California

April 1979

Annual Delays

Average annual delays to aircraft were computed by PMM&Co. using the FAA annual delay model. The delays were computed for 1977, 1982, and 1987 using different near-term improvement packages, different future ATC scenarios, and different operating assumptions.

The total annual demand was forecasted to increase from 349,011 operations in 1977, to 390,800 in 1982, and 421,200 in 1987. The mix changed as follows:

	Percent			
Year	A	B	C	D
1977	6%	16%	60%	18%
1982	6	18	57	19
1987	5	17	53	25

The results of the experiments are summarized in Table 1. Average annual delays are given for each of the eleven experiments. In addition, average peak-hour delays are given for the most commonly occurring runway use (arrivals on Runways 28L and 28R, and departures on Runways 1L, 1R, and 28R) in VFR and IFR weather. These results are also shown graphically in Figure 1.

As shown in Table 1 and Figure 1, under the do-nothing (1977) ATC scenario, annual delays increased 26% from 2.1 minutes in 1977, to 3.6 minutes in 1982, and 5.6 minutes in 1987.

Review of the detailed computer output for the 1977 delay results showed that about 40% of the total annual delays took place in VFR weather (which occurs more than 92% of the year) and about 60% took place in IFR weather (which occurs less than 8% of the year).

Delays increase by about 70% in 1982 if no improvements are made and with no ATC scenario change. If both the 1982 near-term improvements package at the 1982 ATC scenario were implemented, delays would change very little from 1977 (even though demand has increased).

By 1987, the amount of average annual delay per aircraft is highly dependent on which near-term improvements are implemented and which ATC scenarios occur.

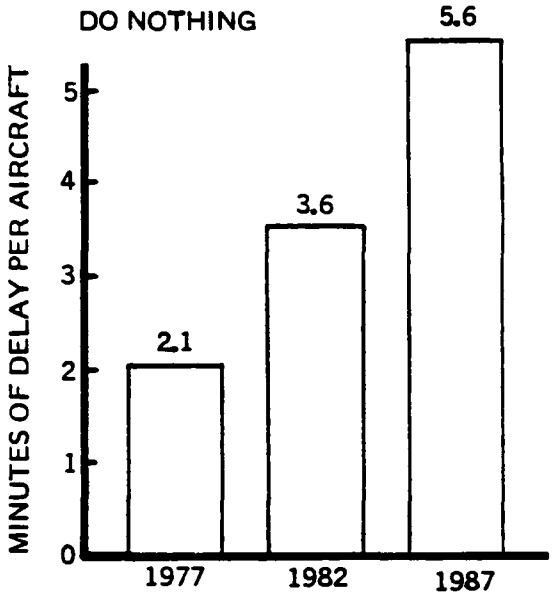
In both the 1987 improvement package and the 1987 ATC scenario are implemented, average annual delays are estimated to be as low as 1.2 minutes--a savings of about 4.4 minutes per aircraft when compared with the do-nothing scenario (if 2 mile separations are achieved; 3.4 minutes if 2-1/2 mile separations are achieved).

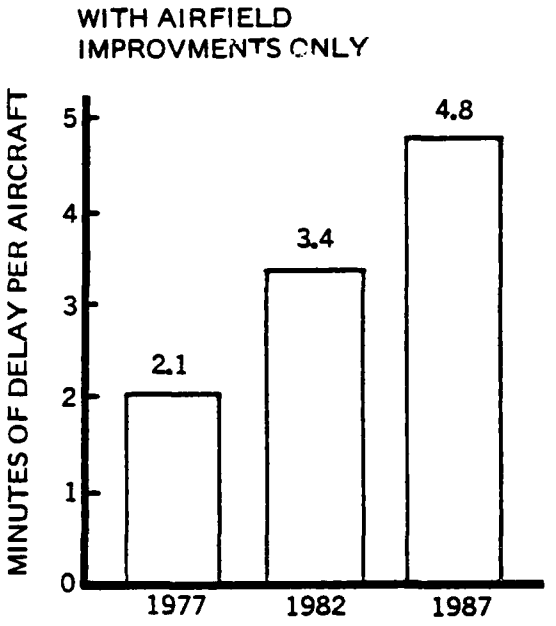
Table 1

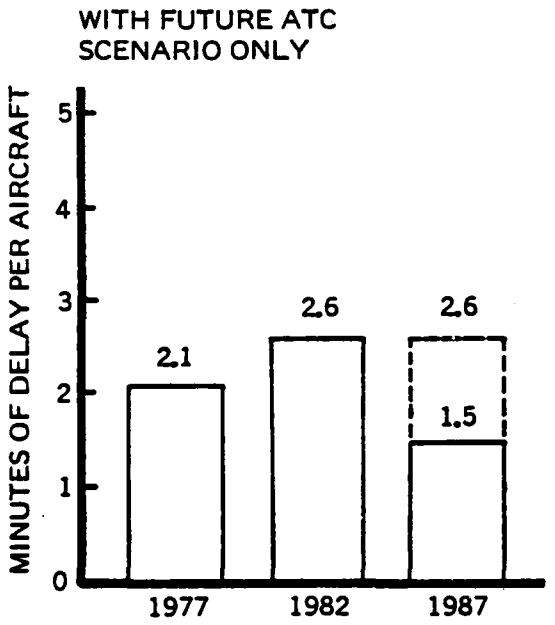
SUMMARY OF ANNUAL DELAY MODEL EXPERIMENTS
San Francisco International Airport

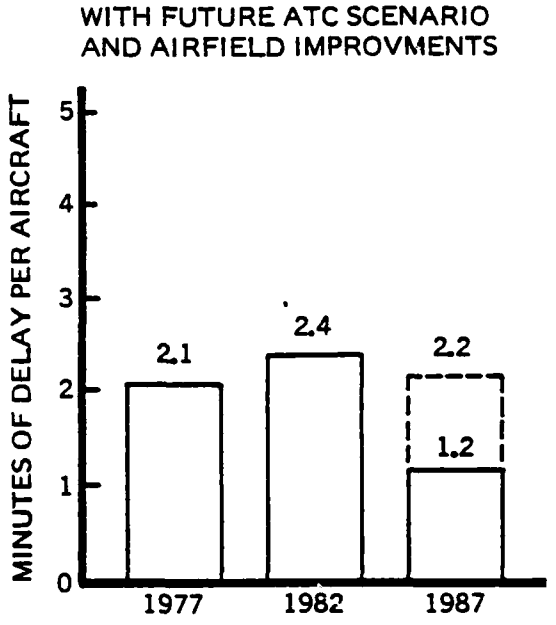
Experiment No.	Demand	ATC Scenario	Airfield Improvements	Annual Delay (hours)	Average Aircraft Delay (minutes)	Average Peak-Hour Delays (arrivals on 28R, 28L departures on 1R, 1L, 28L) VFR	IFR
16	1977	1977	1977	12,267	2.1	1.2	60.2
17[a]	1977	1977	1977	10,021	1.7	1.2	60.2
24	1982	1977	1977	23,639	3.6	1.5	71.4
25	1982	1977	1982	22,430	3.4	1.7	81.3
26	1982	1982	1982	15,813	2.4	1.5	63.7
27	1982	1982	1977	16,847	2.6	1.8	70.2
28[a]	1982	1982	1982	10,104	1.6	1.5	63.7
29	1987	1977	1977	39,018	5.6	1.9	82.1
30	1987	1977	1987	33,748	4.8	1.8	82.1
31	1987	1987	1987	8,253	1.2	1.3	8.0
31A[b]	1987	1987	1987	15,638	2.2	1.6	58.4
32	1987	1987	1977	10,707	1.5	1.4	12.0
32A[b]	1987	1987	1977	18,161	2.6	1.6	61.0
33[a]	1987	1987	1987	6,069	0.9	1.3	8.0

a. These experiments are designed to evaluate the effects of noise abatement procedures.
b. These experiments assumed 2-1/2 mile separations instead of 2 miles.









Source: PMM & Co. estimates based on Task Force inputs.

———— Assumes 2½ mile seperations

Figure 1
ANNUAL DELAYS
San Francisco International Airport
PMM & Co. April 1979

The operational constraints imposed by the noise abatement procedures has the following affects (assuming ATC scenarios improve as appropriate).

Year	Noise Abatement Policy Delay Level	Delay Level With No Operating Constraints
1977	2.1	1.7
1982	2.4	1.6
1987	1.2	0.9

The average delay (total delay) to aircraft in delay for the noise abatement procedures is 0.4 (140,000) minutes in 1977, 0.8 (310,000) minutes in 1982 and 0.3 (125,000) minutes in 1987.